SCIENCE FOR GLASS PRODUCTION

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DETERMINATION OF THE THICKNESS OF THE GLASS BAND IN A TANK WITH MELTED TIN AT DIFFERENT STAGES OF MOLDING

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A method for determination of the geometric parameters of the glass band in a tank with tin melt is developed, and the effect of molding conditions on these parameters is investigated. Data providing a more accurate understanding of the processes in different stages of molding are obtained and systematized. It is established that an equilibrium glass band thickness is formed under the effect of the edge-restricting machines and not in free spreading of the melt in the initial stage of molding, as was earlier believed.

In float-molding of glass, glass melt via a dosing unit is discharged into a tank filled with melted tin, spreading and taking the form of a plane-parallel band. This band acquires preset width and thickness under the effect of the edge-restricting machines and the roller conveyor of the annealing furnace. The width and the thickness of the glass band vary along the tank with the tin melt.

Measurements of the width of a glass band in a melt tank at various stages of molding is currently accessible and sufficiently well studied.

Information regarding the variations in the band thickness in molding is limited and contradictory. In particular, the authors of [1 – 3] and many others assert that a glass band can acquire an equilibrium width in spreading up to the site where the edge-restricting machines are installed. The authors of [4], on the contrary, note that glass up to 12 mm thick can be obtained without restricting the glass spreading towards the tank rims.

Measuring of the glass band thickness in molding is impeded by a number of reasons, primarily by a need for the measuring instrument to penetrate into the bottom part of the glass band that is immersed in tin and keeps moving in a viscofluid state.

Data on the methods for measuring the glass band thickness in a melt tank are limited and do not have practical meaning (U.S. Patent No. 3356479, USSR Inventor’s Certif. No. 837944).

We have developed a method for determining the glass band thickness in a melt tank at various stages of molding and have tested it on a production line. In our opinion, this method is sufficiently simple and accessible.

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The method is based on the principle according to which an identical quantity of glass melt passes per time unit through each section of the melt tank perpendicular to the direction of the band motion [5]:

$$Q = \delta b v \rho, \tag{1}$$

where Q is the quantity of glass melt, kg/h; δ is the glass band thickness, m; b is the glass band width, m; v is the velocity of the band motion across a particular section, m/sec; ρ is the glass density, kg/m^3.

The band thickness across the section is expressed by the formula

$$\delta = \frac{Q}{bv\rho}. \tag{2}$$

Figure 1 shows the scheme of a float-glass production line and indicates the parameters measured according to the method proposed.

The system includes a tank *1* with the tin melt, on which a glass band *2* is moving. A force for the transportation of the band is developed by the roller conveyer of the annealing furnace *3*. The formation of the band with the purpose of obtaining the prescribed geometrical characteristics is implemented by several pairs of edge-restricting machines *4*. The imprints of the machine impact in the glass band are indicated by dashed lines.

All technological parameters are maintained constant during the measurements.

To determine the output, it is necessary to measure b_3, δ_3, and v_3 (the width, the thickness, and the velocity of the

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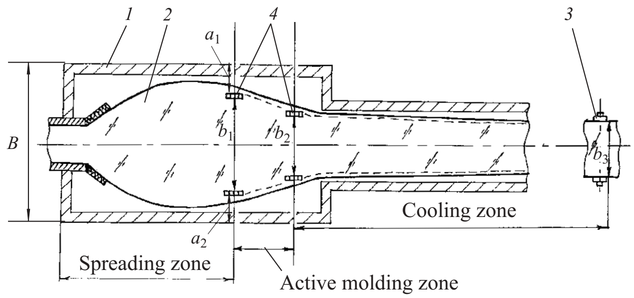

Fig. 1. Scheme of the melt tank: b_1 and b_2) glass band thickness in the zones of the first and the second pair of the edge-restricting machines, respectively; b_3) glass band width at the exit from the annealing furnace; B) width of the tin melt tank; a_1 and a_2) respective distances between the rollers of the edge-restricting machines and the right and the left sides of the tank.

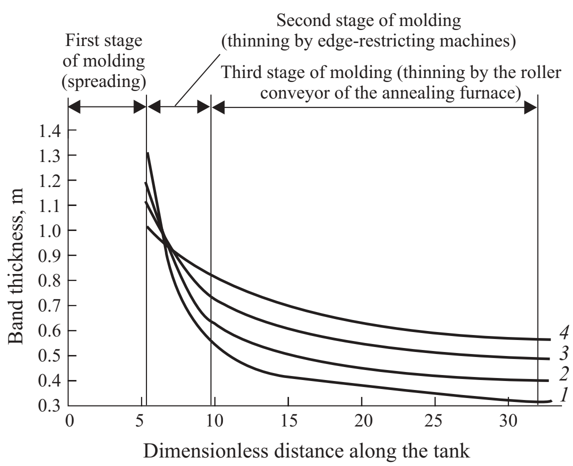

Fig. 2. Variation of the glass band thickness in a melt tank: *1*, *2*, *3*, and *4*) band thickness at the exit from the annealing furnace equal to 3, 4, 5, and 6 mm, respectively.

band at the exit from the annealing furnace, respectively) and to calculate it based on formula (1).

The band width in the zone of location of the first pair of the edge-restricting machines reckoned from the discharge can be defined as the difference between the tank width and the overall distance between the rollers of the edge-restricting machines and the tank edges:

$$b_1 = B - (a_1 + a_2),$$

where b_1 is the band width in the zone of location of the first pair of the edge-restricting machines, m; B is the width of the tank with the tin melt, m; a_1 and a_2 are the respective distances of the edge-holding machine rollers from the right and the left side of the tank, m.

The band motion velocity is taken as the linear velocity of a roller or a track link in the zone of contact with the glass band. The width for this part of the band is determined based on formula (2). The thickness of the middle part of the band in that section can differ slightly from the value obtained.

Similar measurements and calculations are carried out for subsequent machine pairs, the output being equal. The accuracy of the determination of the band thickness depends on the accuracy of measuring the parameters that comprise the formula and may amount to ± 3%. If a higher accuracy is required, a correction is introduced into formula (1) to take into account the variation in the glass density depending on the temperature at which the measurement is made.

Measurements of thickness were carried out on float-glass production lines with an output of 100, 400, and 600 tons/day. Figure 2 shows the variations of the band thickness at different molding stages in producing glass with a thickness below the equilibrium value.

It is established that the glass band thickness at the first stage (spreading) is 10 mm or more. Only after the impact of the edge-restricting machines at the second stage does the thickness approach the equilibrium value. The thinning of the band at the third stage due to the impact of the roller conveyor of the annealing furnace is comparable to the thinning of the band in the second stage.

The thinner the glass produced, the greater the thickness of the band at the boundary between the spreading zone and the active molding zone. In particular, when making glass 3 mm thick, this parameter is equal to 13 mm, and in making 6 mm glass it is approximately 10 mm. In any case this value is significantly above an equilibrium thickness value. An equilibrium thickness in reality is reached in the zone of the effect of the edge-restricting machines.

Considering the consecutive modification of thickness along the molding zones, the edge-restricting machines decrease the band thickness virtually by half, after which the roller conveyor of the annealing furnace makes it even 1/3 to 2 times thinner.

Thus, a glass band acquires an equilibrium thickness not through free spreading but primarily due to the effect of the edge-restricting machines.

It should be noted that besides determining the band thickness at prearranged sections, this method can be used to solve other problems. In particular, it is possible to calculate other parameters in the molding zones based on a preset thickness.

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